JIMMA UNIVERSITY,

COLLEGE OF NATURAL SCIENCES,

DEPARTMENT OF BIOLOGY

DIVERSITY AND RELATIVE ABUNDANCE OF AVIFAUNA IN AND AROUND ABA-JIFAR AIRPORT AND THEIR POTENTIAL THREAT ON THE AVIATION ACTIVITIES JIMMA, ETHIOPIA

BY: BELAYNESH GULAL ATENA

MARCH, 2021

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A THESIS SUBMITTED TO DEPARTMENT OF BIOLOGY, COLLAGE OF NATURAL SCIENCES, JIMMA UNIVERSITY, FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE DEGREE OF MASTER OF SCIENCE IN BIOLOGY (ECOLOGICAL AND SYSTEMATIC ZOOLOGY)

MARCH, 2021
JIMMA, ETHIOPIA

Declaration

I, hereby declare that this thesis is my original work and has not been presented for any degree in any other University, and all the source materials used for this thesis have been properly acknowledged.

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Date of submission ________________

This research has been submitted for examination with my approval as the University Supervisors.

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Date: ____________	Date: ____________

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Abbreviation

ATSB - Australian Transport Safety Bureau

BLI - Bird Life International

ECAA - Ethiopian Civil Aviation Authority

EWNHS - Ethiopian Wildlife and Natural History Society

FAA - Federal Aviation Administration

IBSC - International Bird Strike Committee

ICAO - International Civil Aviation Organization

UKCAA - United Kingdom Civil Aviation Authority

Abstract

Birds are components of biodiversity that play a vital role as bio indicator, however they also pose substantial hazard to air craft safeties. Study on species diversity and relative abundance of birds in and around Jimma Aba-Jifar Airport, Jimma and their impact on aviation industry was conducted from February to April, 2020(dry season) and from June to August, 2020 (wet season). Both point and transect count methods were employed to record bird species composition and their abundance. Observation was conducted by periodically walking along the study area early in the morning and late in the afternoon. Bird species diversity and their attractant feature were investigated. Diversity indices of birds in three study sites were calculated using the Shannon-Wiener diversity index. A total of 49 bird species belonging to 10 order and 25 families were recorded from all study sites. The highest number of species was recorded from the Airport compounds (39 and 42 species) during dry and wet season respectively; and the least number was recorded from the wetland habitat (14 species) in each season. Bird species diversity was highest in Airport compound (H'=3.49 and H'=3.57) during dry and wet season respectively. In contrast, the lowest species diversity was recorded in the wetland (H'=2.47and H'= 2.58) during dry and wet season respectively. Individual bird species were evenly distributed in each study sites during wet and dry seasons. There were no injuries or fatalities reported because of bird strikes during the study period in the study area. However; due to the presence of natural (water, grassland, vegetation) and manmade (waste dumping site, buildings and light pole) bird attractant features in and around the airport, different species of bird including hazardous birds that pose potential hazard to aircraft safety were recorded. Therefore, applying effective bird control method is recommended in order to control bird of Jimma Aba Jifar Airport.

Keyword: *Airport, Airport management, Bird attractant, Bird strike, collision, Jimma Aba-Jifar Airport, Safety threat*

1. Introduction

1.1 Background of the Study

Birds are among the most easily defined and readily recognized categories of animals, due to the presence of feather, which is unique to them. In addition to feathers, the development of forelimbs as wings, mostly for flight; feathered tail that serves for balancing, steering and lifting; toothless horny beak and skeleton exhibiting unique adaptations, mainly for flight and bipedal locomotion are characteristics of birds (Dessalegn, 2011). They are one of the best known and most highly valued elements of the natural world; comprising more than eleven thousand of different species (BLI, 2018). Birds have been particularly useful as bio indicators to evaluate the effects of habitat change (Oduntan *et al*., 2012; Kiros, 2018), because they are easy to watch (Dessalegn, 2011). They have the power of flight to move easily between earth and sky, and they are also perfectly adapted to every environment that man inhabits (Hiwot, 2007).

Airports are one of the structural features in urban environments. Besides offering facilities for aerial transport activities, airports are highly attractive places for birds due to very low levels of human presence and incidental disturbance (Soldatini *et al*., 2010). Wide ranges of wildlife, including birds, are attracted to the natural environment and other human activities within and around the airports (Dessalegn, 2011; Aschalew *et al*., 2017), by providing perfect feeding, resting and nesting areas for many types of birds. Example, the presence of large, open grasses areas in most airport provide perfect feeding, resting and nesting areas for many types of birds (Soldatini *et al*., 2010). The presence short grass in different airport attracts predatory birds such as raptors, in search of rodents and other food sources. Large open hangars and other flat roofed buildings in airport provide excellent nesting areas for gulls and other small birds such as starlings (Australian Transport Safety Bureau,2002).

The presence of birds in airport areas poses substantial hazards to aviation (Soldatini *et al*., 2010), because different species of birds compete for airspace with departing and approaching aircraft at airports worldwide. This results collision or bird strike (Fauzan, 2017). Globally, bird strikes have the most common wildlife encounter and birds were involved in approximately 97% of all reported wildlife strikes (DeVault *et al*, 2017). According to Australian Transport Safety Bureau (2002) the majority of bird strikes occur on or near the airport environment. This corresponds to several critical phases of flight including the approach, landing, take off and climb (Dolbeer, 2000; Jaiye and Vimal, 2013; Mendonca and Wang, 2017). Therefore, birds in the vicinity of airfields are known to present a permanent hazard for aircrafts during take-off and landing (Fauzan, 2017), adequate actions must be adopted to reduce the risk of aircraft accidents due to wildlife (FAA, 2007). The risk of aircraft collisions with wildlife is increasing as air traffic volume increases. Contributing factors include increase in high hazard bird populations, increase in air traffic volumes, plus the restriction of open space environments suitable for birds outside of airports due to urban encroachment (Matyjasiak, 2014).

The problems have caused damage to aircraft, cost airline industry, and loss of human life (Fauzan, 2017). Cleary and Dolbeer (2005) estimated that between 1988 and 2004 about 200 people were killed and 140 civil aircrafts damaged as a result of bird strikes in various parts of the world. The incident in Bahrdar (northern Ethiopia) in 1988, where a 737 Boeing encountered a flock of speckled pigeons (*Columbia guinea*) during-take off is one of the major bird strike events recorded in Ethiopia (Elizabethrt *et al*., 2000). The aircraft was completely destroyed as a result of 15 pigeons ingested into the engine, resulting in the death of 35 people (Elizabethrt *et al*., 200). Thousands of minor incidents, most causing no damage to aircraft, end in precautionary turn backs, engine checks, delays, cancellations and minor repairs that add up to a minimum of $1.2 billion per annum is lost to bird strike by the global aviation industry (Cleary and Dolbeer, 2005) and millions of dollars annually in Ethiopia (Fekadu, 2020).

Since the first bird strike to the present day, bird strike becomes a serious problem (Fauzan, 2017) in areas where airports are situated, in places with different ecological setup that attract bird (Dessalegn, 2011). Many airports have management plan in order to monitor the bird strike problem. However, before any significant management plan is applied, an ecological analysis covering all seasons should be carried out. Jimma AbaJifar airport is the study area. The airport and its surrounding have a number of habitats available to support diverse bird species. However, diversity, distribution, abundance of avian fauna and their potential impact for the aviation industry have no more scientific data in the present study area. Therefore, the aim of the study was to collect data on diversity, abundance of avian fauna and identify their attractant feature and also their potential hazard on aviation activities.

1.2 Statement of the problem

The threat to aircraft safety from aircraft collisions with wildlife, particularly birds, is currently the main issue and is increasing from time to time (Jaiye and Vimal, 2013). In the case of a serious incident, bird strikes can be classified as a serious safety hazard to the aviation industry because of the risk of potential loss of life (FAA, 2007). In addition to the possible loss of life, the aviation industry is suffering extensive financial losses due to bird strikes worldwide. For example, between 2014 and 2018, 416 strikes were reported at Addis Ababa Bole International Airport and the total cost due to wildlife strikes for the last six years was around 143,049,325 Birr (Fekadu, 2020). International Civil Aviation Organization (ICAO) documents and several studies (Elizabethrt *et al*., 2000; Desalegn, 2011; Aschalew *et al*., 2017; Fauzan, 2017; Hangeior, 2018) showed that bird strikes are becoming a serious problem in areas where airports are located, with different ecological environments such as water bodies, farmland, grassland and garbage dumps.

Jimma Aba Jifar Airport is one of Ethiopia's oldest airports, like other airports it has a number of habitats available including wetland, grassland and municipality waste dumping site around the airport provide suitable condition for diverse bird species. Such birds may have a potential impact on the aviation activities. Recording avian diversity, relative abundance and determining their attractant feature in and in the surrounding area of airport, helps to identify the major bird hazardous to aircraft safety and provide baseline data to establish an adequate bird control method in order to prevent bird strike problem in the airport environment. But this information is lacking in the present study area. Therefore, the objective of this research was to fill the gap by documenting avian species diversity abundance, and identifying their attractant characteristics. Thus, the following questions were answered by this research; how much species of birds are found in and around the airport, which species of birds are the most abundant in the study area, what are the major characteristics of bird attractants in and around the airport and which bird species are hazardous to the aviation industry?

1.3 Objective of the study

1.3.1 General Objective

The general objective of the study was to record the avian species diversity and relative abundance in and around Jimma Aba-Jifar Airport and to predict their potential impact on the aviation activities.

1.3.2 Specific Objective

The specific objectives of this study were:

- To record avian species diversity and relative abundance of the study area
- To compare diversity of bird species among different site of the study area.
- To assess the seasonal variation in the diversity and abundance of bird in the study area
- To identify major bird attractant features in the study area.
- To identify bird species which poses a potential threat to aircraft safety in the study area

1.4 Significance of the Study

The finding of this study provides ecological information on diversity and abundances avian species. The study also identified birds which are the major threat to aircraft and their attractant features within and in the surrounding of the study area, which gives signal to stakeholders to make an appropriate management plan to minimize the impact of bird strike on aviation activities. The result of the study will also serve as source of reference to other researcher, who wants to make further study.

2. Literature Review

2.1 Avian species diversity and distribution

The species composition in a given area is mostly explained by historical factors such as dispersal events, geographical isolation, and extinction due to past climatic and geological events, and in much less extent by some ecological factors such as competition and predation (Barrantes and Sandoval, 2009). A number of variables have been found to influence bird species diversity within a landscape. These include the area of habitat patch in which the species nests, the amount of habitat within the landscape, degree of fragmentation and vegetation characteristics of the habitat. Differences in species richness and composition among localities within a landscape and among landscapes may be due to species interactions as well as the interaction of each species with the abiotic environment (Veech and Crist, 2007). Environmental heterogeneity in the form of spatial variation in habitat and local climate can affect species distributions.

Due to the power of flight birds move easily between earth and sky, and they are also perfectly adapted to every environment that man inhabits. Although birds collectively occupy most of the earth's surface, most species are found only in particular regions and habitats, whereas others are cosmopolitan (Hiwot, 2007). The ranging and breeding ecology of many bird species in a given ecosystem are the result of food availability and suitability of vegetation cover. They can feed on variety of food items and nest on infinite variety of sites (Sodhi, 2002). Birds are the most abundant vertebrates next to fish. There are over 11,000 various species of birds grouped in 29 Orders and 181 families currently inhabit the earth (Hiwot, 2007). Across the world Africa is second only to South America in terms of numbers of bird species, and arguably offers more rewarding birding than other tropical regions. The continent supports more than 2100 of the world's bird species, out of which almost 1400 are endemic species in a diversity of habitats (Sinclair and Ryan, 2003).

Ethiopia consists of diverse climatic and physical conditions and topographical variation (Getahun, 2018). This created diverse ecosystems (e.g., forests, grass lands, wetlands and semi-arid environments) which have their own distinctive climatic conditions, and support different plant and animal species including various bird species depending up on their habitat requirements

(Girma *et al*., 2017). The temporal and spatial species composition and abundance of birds in Ethiopia are mainly determined by vegetation structures used as food source, breeding sites and protection (shelter) resulting from climatic variations such as rainfall and temperature related to the topographical nature of a particular area (Areaya *et al*., 2013; Girma *et al*.,2017).

In terms of its avifauna, Ethiopia is one of the well-known countries in Africa, with 926 species, that vary from residents to breeding, migrants to wintering birds (Aynalem and Bekele, 2008; Ayalew *et al*., 2019). Twenty-four of these species are national endemics and nineteen are listed as globally threatened (Tesfahunegny, 2016) of which two species are critically endangered, five species endangered, and twelve species vulnerable (EWNHS, 1996).

Among the elements of the diversity of nature, birds are both visually and acoustically conspicuous organisms of most ecosystems and the best-known class of organisms (BLI, 2018). They are an integral part of an ecosystem and occupy many trophic levels in a food chain ranging from consumers to predators; and they play roles in ecosystem functioning and socio-economic contributions. Birds are well known bio-indicators and they have a significant role in ecosystem functioning and balancing (Areaya *et al*., 2013). They are agents of nutrient cycles, plant gene flow through pollination, seed dispersal, controls population size of harmful insects, environmental sanitation through scavenging of carrion (Tesfahunegny *et al*., 2016). Birds are also important components of tourism industries in many countries and they support the economic growth of a particular a country (Areaya *et al*., 2013), because of their distinctive colors, songs, calls, displays and dancing.

2.2 Impact of avian species on aviation industry

The presence of birds in airport areas poses substantial hazards to aviation because, birds and aircraft share the air (Oduntan et *al*., 2012). Before the advent of aircraft, birds, bats and insects used the skies. Sharing the skies and the environment with aircraft has often times resulted in collision of aircrafts, wildlife and birds. A bird strike is strictly defined as a collision between a bird and an aircraft (Fauzan, 2017) which is in flight or on a takeoff or landing roll. The problem has posed threat ranging from cracked windshields, dented wind edges and minor fuselage damage to air crashes. The International Federation of Airline Pilot Association, a body representing over 100,000 licensed airline professionals worldwide has become so concerned with the peril from bird strike that it recently upgraded this hazard to a category “A” safety hazard, the highest level of concern (Oduntan *et al*., 2012).

Since the beginning of the aviation industry the conflict has resulted in aircraft sustaining serious damage as a result of a collision with a bird. With the advancement and dramatic expansion experienced in the aviation industry the risk has become increasingly higher and more serious accidents have occurred (Fauzan, 2017). However, not all species pose a bird strike threat (Soldatini, 2010). A species’ distribution at airports depends on the geography and surrounding habitats; therefore, it is expected that different bird communities will be present at different airports. For example: According to the National Wildlife Strike Database, geese, vultures, rock doves, ducks and gulls are the most dangerous birds in terms of the total number of strikes and the cost per strike in USA (Dolbeer *et al.*, 2000). On the other hand, in Italy, gulls, lapwings, starlings and hooded crows were recorded as dangerous species at Rome Fiumicino Airport (Montemaggiori ,1998), and herons and gulls were reported as the most dangerous at Venice Marco Polo International Airport (Soldatini, 2010).

According to FAA (2009), bird strike commonly happens at low altitude flight or when aircraft takeoff and landing. It has been widely documented that collisions of aircrafts with birds are more common at altitudes lower than 500 ft, mainly during takeoff and landings (Dolbeer, 2000; Jaiye and Vimal, 2013; Mendonca and Wang, 2017). The first reported bird strike was recorded by Oliver Wright in his diary on 7 September 1905 when his aircraft hit a bird near Dayton Ohio. On 3 April 1912, Calbraith Rodgers, the first person to fly across the continental United States was the first died as a result of bird strike when his aircraft struck a gull along the coast of Southern California (Fauzan, 2017**).** Since the first bird strike to the present day, bird strikes can be classified as a serious safety hazard to the aviation industry due to the risk of potential loss of life in the case of a serious incident. Apart from the possible loss of life, internationally the aviation industry suffers extensive financial losses due to bird strikes (Jaiye and Vimal, 2013). Several accidents have already occurred at different part of the world. The most fatal air crash caused by birds occurred in Boston, USA in 1960 killing 62 people (Thorpe, 2005). Between 2005 and 2010, a total of 209 strike incidents were reported in Nigeria, Kites and hawks were found to be responsible for 57 percent of reported strikes (Usman *et al.*, 2012).

The most serious bird strike incident occurred at Bahar Dar Airport in Ethiopia during 1988 when a Boeing 737 encountered a flock of Speckled Pigeon, (Columbia guinea) during takeoff. The aircraft was completely destroyed at the Nile River bank resulting in the death of 35 people (Elizabeth *et al*., 2000). There are also documents about bird strike from Bole international airport, Ethiopia. Ninety percent of the strikes occurred on or in the vicinity of the airport and resulted in material damage as well as delay of arrival and departure of flights (Dessalegn, 2011; Fekadu, 2020).

2.2 Factors influencing the frequency of bird strike

2.2.1 An increase in the number of bird and intensity of flight

The increase in numbers of birds noted over last decades mainly refers to the species inhabiting open habitats such as farmland and bodies of water (UK CAA, 2007). Typically, these are common species rapidly adapting to anthropogenic habitats, easily colonizing urban areas, thus also surroundings of airports, and using food provided by people. Many factors are responsible for an increase in bird populations. The most important factor is an increase in habitat fertility as a result of the economic activity of people, significantly increasing the available food supply for some common bird species. An increasing number of flight operations and air corridors intensify competition for space between aircraft and birds, which increase the risk of bird strikes (Sodhi, 2002).

2.2.2 Habitats attractive to birds within airports

Wide ranges of wildlife, including birds, are attracted to the natural environment and other human activities within and near airports (Dessalegn, 2011; Aschalew *et al*., 2017). Vast, open and flat area of an airport is very attractive to such birds as gulls, lapwings, starlings, corvids, and geese. From the viewpoint of birds, a vast area of the airport is empty and safe because no people are present there and they can spot possible predators from a safe distance (Matyjasiak, 2008). Birds are not afraid of aircraft because they do not identify them as predators. They view the airport as a safe place for resting, bathing, gathering in flocks, or hiding from predators. The airport can then become the only open and relatively safe area, where birds can find peace (Cleary and Dolbeer, 2005).

In addition to safety, birds can find food and water for drinking and bathing at the airport. Airfield grass spaces are inhabited by a variety of animals such as rodents, insects, earthworms, and other invertebrates (Dessalegn, 2011). There are also different plants producing fruits and seeds, such as grasses and other herbaceous plants, decorative trees and shrubs planted in groups or forming hedgerows surrounding the airport area.

2.2.3 Habitats attractive to birds in areas surrounding Airports

The airport is a part of the local ecosystem and for this reason the occurrence of birds at the airport also depends on the attractiveness of the surrounding habitats (Cleary and Dolbeer 2005). Areas near airports are often used for location of investments objectionable in other places, for example, disposal sites of communal wastes, sewage treatment plants, industrial works, and even meat-and-fish processing plants. Many of these objects can attract different bird species. The airports located in agricultural landscape are surrounded by different crops and plantations, including cereals and sunflowers that are very attractive to many small passerine birds (Usman *et al*., 2012). Some vegetables attract birds, for instance, cucumbers can attract gulls. Also, plantations of decorative trees and shrubs producing sweet, fleshy fruits, grown at the terminal or in built-up areas around the airport, act in the same way. Because of an increase in the population size of some bird species, such a location gives rise to problems related to the declining flight safety (UK CAA 2002; Cleary and Dolbeer 2005).

2.2.4 Time of the day and season of the year

The majority of bird strikes occur during the day, most frequently in the morning and early evening (Elizabeth *et al*., 2000; Cleary and Dolbeer 2005). Early in the morning and in the evening, birds are most active because they move to foraging grounds or to nocturnal roosting sites. In other parts of the day they forage, rest, or hide from predators. Lower number of birds strikes at night is due not only to a smaller number of flying birds, but also to a smaller number of flight operations at night (Matyjasiak, 2008).

The frequency distribution of bird strikes has three peaks – two of them coincide with the periods of spring and autumn migrations, and the third occurs shortly after young birds left their nests, in July and August (Kelly *et al*. 2001). An increase in the risk of bird strikes in these cases is a result of the arrival of a large number of inexperienced birds - young from the local breeding population or migrants from distant areas. Newcomers do not know that they should not approach to the runways and aircrafts. Their behavior is unpredictable. When frightened, they easily run into panic and circle in dense flocks in the zone of approach to the airport (e.g., starlings and plovers), creating a threat of collision with the aircraft (Cleary and Dolbeer 2005). Of these three peaks, the summer and autumn ones are the highest (about 51 percent of the collisions were noted in the period of four months between July and October (Cleary *et al*., 2006). The reason is that a great proportion of the local population and passing birds consist of young birds of the year. In spring, the number of returning migrants is lower due to their natural mortality. The frequency of bird strikes considerably declines in the periods when the populations of birds occurring near airports are stable. This takes place in the breeding season, at the end of summer and in early autumn, also in winter (Matyjasiak, 2008).

2.3 Strategies of airport protection against birds

The methods applied to minimize the risk of bird strikes to aircraft consist in the limitation of the occurrence of birds in places where the competition for space between aircraft and birds is heaviest, thus at airports and near them (Cleary and Dolbeer 2005; UK CAA, 2007). In some cases, there may be a need for applying measures against bird communities and their habitats not only at the airport but also in surrounding areas. According to Usman *et al.*, (2012) four main groups of strategies are used to control bird strike in the aviation industry today. These include flight schedule modification, habitat modification (management), and Resource protection and population management.

2.3.1 Flight schedule modification

Modifying flight paths and flight times is one way to attempt to reduce the number of birds strikes that occur (Thompson, 2010). This method is based on the adaptation of the flight schedule, the ways of approaches to the airport and departures to the behavior of birds. For example, departures can be stopped for half an hour to one hour at sunrise and sunset, when large flocks of starlings move between the communal roosting site located at a near wetland and foraging grounds. Flight controllers can order a break in flights to let go first the flock of geese passing over the airport. They can close the runway where a high activity of passing birds was noted until the bird-control patrol disperses them. The best solution is to plan the approaches and taking off routes in a way that they do not collide with sites of bird concentration nor at different heights neither on the routes of daily or seasonal movements of birds. A deep knowledge of the flyways of birds and passage dates is needed. This method can be used in small, regional airports with a low intensity of flights. At international airports with a high intensity of flight operations it can be troublesome (Cleary and Dolbeer 2005).

2.3.2 Habitat modification

All birds require food, shelter (including shelter, safety, nesting and roosting) and water to survive (Desoky, 2014). The technique of habitat modification includes changing the habitat to reduce their attractiveness of birds and other wildlife (Usman *et al*., 2012). Reducing the attractiveness of airfield to birds and other wildlife is very important in bird control (Burger, 1983). The type of habitat management adopted will depend on the bird/wildlife species involved. It may however require improving drainage within and around the airfield, removing trees used for nesting and netting of water bodies (Burger, 1983). Fitting of bird anti-perching spikes on runway and taxiway signage boards has also been used to prevent birds from using airfield infrastructure as perches (Usman *et al*., 2012).

2.3.3 Resource protection

Resource protection comprises all activities that make areas inaccessible or less attractive to birds (Desoky, 2014). Apart from food, cover and water, airports often offer relative ‘quiet’ conditions. This is attractive to birds and can be an important factor in their presence (Burger, 1983). Resource protection measures include ‘passive’ (e.g. wires across ponds, spikes on ledges) and ‘active’ (harassment with chemical, audio or visual means) methods (Burger, 1983; National Wildlife Research Centre, 1999).

2.3.4 Population management

Population management is generally considered a last option, when other measures fail (Burger, 1983). It consists of capturing or killing target birds (Desoky, 2014). In most countries, a large number of birds are under protection, although permits can be obtained for specific purposes. Killing birds is generally considered as a ‘last resort’, only used when other techniques fail (Stenman, 1990).

3. Study Area and Methods

3.1 Description of the study area

The study was conducted in and around Jimma Aba-Jifar Airport, Jimma city, Southwestern Ethiopia, located at a distance of 355 km. The airport is located 2.5 km southwest of Jimma city. It is the oldest airport in the Ethiopia aviation, established in 1972. The first runway and terminal were constructed in 1962 and 1964 respectively (Jimma airport, 2012). But know, there is a new and modern runway and terminal built. The new airport lies on about 4.7 km^2 area, including the old Jimma airport. The geographical location of the airport is located at coordinate points 7° 39'58" N, 36°49' 00" E and average elevation is about 1703 m above sea level (Figure 1). The airport has been given an upgrading priority to an international standard with all facilities to host international flights. The upgrading program incorporates the expansion of the compound that doubles the previous area (Tadesse *et al.,* 2012). The zone in which the airport is situated is very fertile and conducive for agriculture, agro-industry and trade. The airport compound is dominated by few species of grass including *Stipa keniensi*, *Hyparrhenia rufa, Sporobolus pyramidalis* and *Eulalia polyneura* (Tadesse *et al.,* 2012). In this study, in addition to the airport compound Waste dumping site was purposively selected that is found near the airport, where birds are concentrated. Waste dumping site is found in the southwest direction at a distance of approximately 1.2 km from the airport. Eucalyptus and *Psidium guajava* are the main plant species found around this site. Different types of wastes are deposited into this site such as plastics, wood products, carrions, bones, scraps of meat and various unwanted fruits.

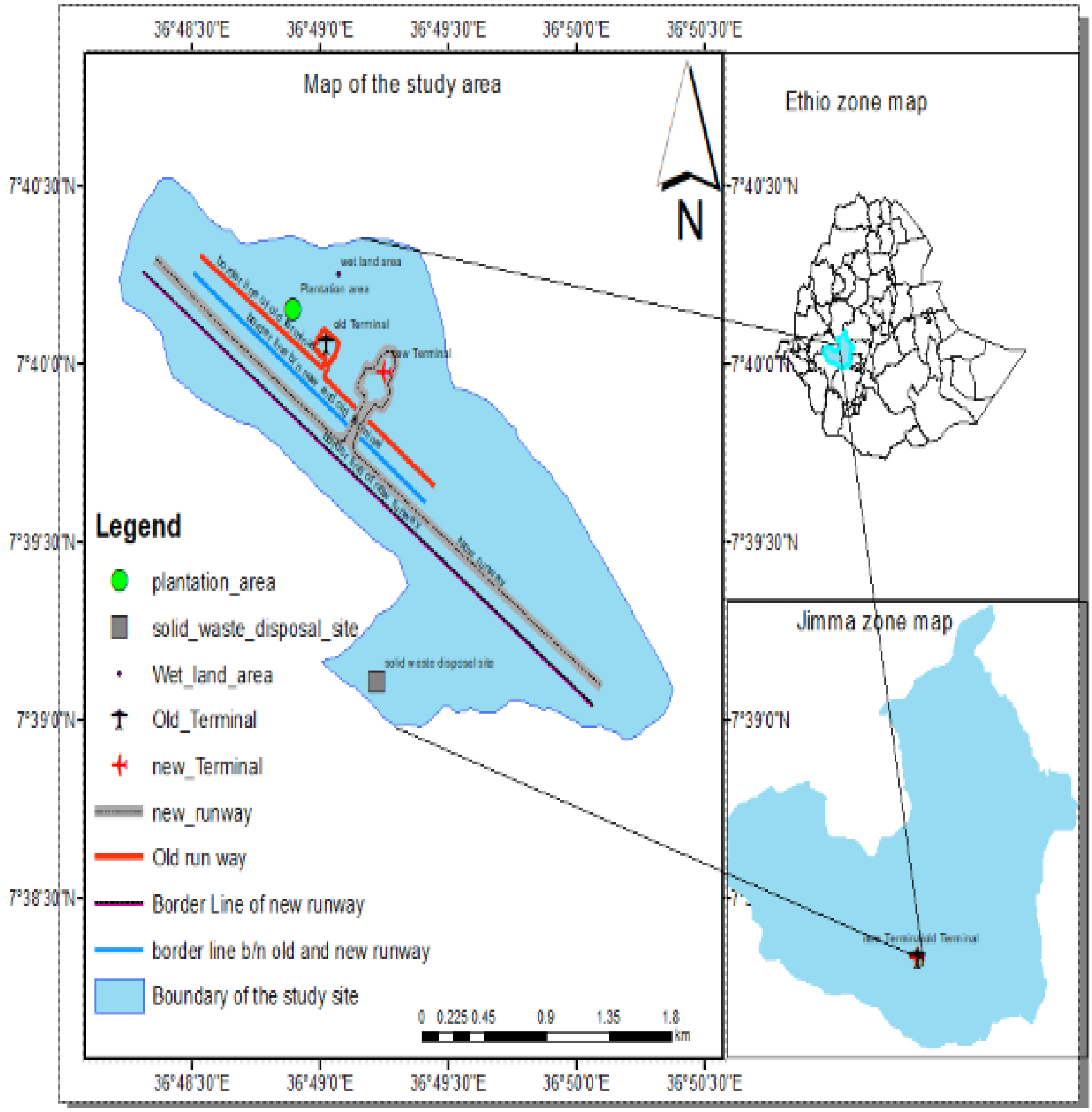

Figure 1: Map of the Study Area

3.2 Climate

Data used for the description of rainfall and temperature record of the study area was collected from EMA, West Oromia branch. According to the five years rainfall summarized data (2016 - 2020), the rainfall in the area is uni-modal (having one long rain season) between May and

September with a peak in August (with mean monthly rainfall of 1250.5 mm. A marked dry season ranges from December to February (Figure 2).

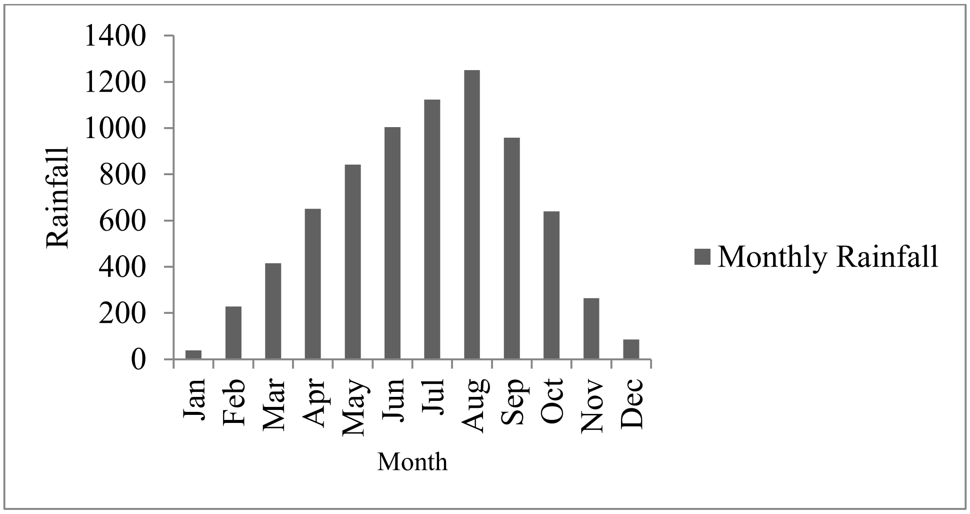

Figure 2: Mean monthly rainfall (mm) of study area (2016-2020).

The average monthly maximum and minimum temperature of study area were recorded in February (30.2^{0C}) and December (7.53^{oc}) respectively with mean daily temperature 19.3^{oc} (EMA, 2020) (Fig. 3).

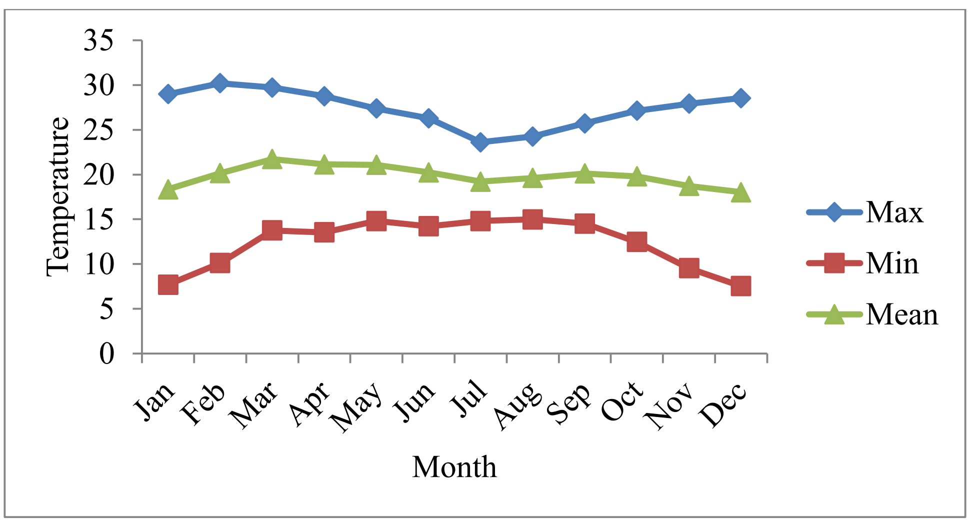

Figure 3: Monthly average maximum and minimum temperature of study area

3.3 Materials and Methods

3.3.1 Materials

The following materials have been used during the survey period. These were binoculars 10*50; GPS; digital cameras; field guide book; data sheets and note books.

3.3.2 Preliminary survey

Before data collection a preliminary survey was conducted from October 20 to 25, 2019 to gather all the relevant information such as vegetation cover, habitat type and the overall ecological feature of the study area which attracts bird species. Such information was gathered by direct observation and from concerned bodies of Jimma Aba Jifar airport. Then the study area was classified into three sites based on the nature of the habitat (waste dumping site, airport compound, and wetland).

3.3.3 Study design

Transect count and point count methods were randomly selected to study the diversity and abundance of birds in and around the airport. Then line transect were randomly established in airport compound along the two runway and point count station selection was performed in wetland and waste dumping sites. Then data were collected using point and line transects methods to estimate the diversity and abundance of birds in the study area (Gibbons & Gregory, 2006; Lameed, 2011). The availability of bird attractant feature such as food, water, shelter, and cover sources were considered during study period.

3.3.4 Data Collection methods

3.3.4.1 Line transect

A total of four representative line transects were randomly established along the length of old and new run way (two for each) and permanently used for both seasons. Points for the transect count method were placed by walking along the two runways. The length of each transects were 1k.m.

There was 500m distance between any two transects to prevent double counting of the same individual of a species. The sighting distance (on either side of the transect line) was 50m. Then the observer moved slowly along the line during the survey and recorded all the birds detected on either side of the line (Lameed, 2011; Gibbons & Gregory, 2006).

3.3.4.2 Point Count

A total of six- and eight-point count stations were randomly selected to enumerate birds of waste dumping site and wetland habitats respectively. Stations for the point count method were selected depending on the abundance and activity of birds. Each point transect were 300 m far away from each other to avoid double counting of the same individual of a species (Gregory *et al*., 2004). Point count method was undertaken from a fixed location within the sample unit of radius 15 to 50 m with a fixed time interval consisting of 5– 10 minutes. To minimize disturbance during counts, a waiting period of 3–5 minutes prior to counting was applied. Each point count station was visited by the observer and all birds seen or heard during a set period of time were counted.

The actual study was carried out from February to April, 2020 (dry season) and from June to august, 2020 (wet season). Data were taken for three days per week in each month depending on the weather conditions and time of the day when bird species were active. Data were collected early in the early morning (6:30-10:00 a.m.) and in the late afternoon (16:00-18:00 p.m.); these are the periods where most of the avian species are active. Plumage pattern, size, shape and color were considered as important parameters for identification of species. During the survey, the availability of birds was observed by naked eye and using binoculars. Field data sheets were used to record the observations. The species and individual of each bird species were recorded. Photographs were taken to confirm the identification of some of the species. The taxonomic groups of birds were categorized based on field guide book (Redman *et al*., 2009) and other standardized references. Natural and human made bird attractant feature in and around the airport were recorded by direct observation, meaning the availability of attractants that includes food, water, shelter, and cover sources for different bird species were identified and recorded.

3.3.5 Data analysis

All records data were in a tabular form in the excel data sheet and the data were analyzed. Given that; Bird diversity for each study site was calculated using Shannon-Weiner diversity index (H′) to compare the diversity of bird species among the different habitats (Shannon and Weaver, 1949) it was calculated as:

$$H' = -\sum [\{\frac{ni}{N}\} \times ln[\{\frac{ni}{N}\}]$$

Where ni = is number of individuals of each species

N = is total number of individuals for the site

ln =Natural logarithm

Species evenness, which measures the pattern of distribution of the bird populations present in the area, was evaluated using Shannon-Wiener evenness Index (E) it was calculated as follows:

$$E = \frac{H'}{Hmax}$$

Where H' = Shannon-Weaver Index

H max = Ln S and

S = the total number of species (S) in each site) (Tramer, 1969).

Based on the collected data the relative abundance of bird species was calculated by dividing the number of records of each species by the total number of records of all species, calculated as follows:

$$\text{Relative abundance} = \frac{n}{N}$$

Where n = the total number of birds of a particular species and

N = the total number of birds of all species

4. Results

4.1 Species Composition

In the present study, a total of 49 species of birds belonging to 10 orders and 25 families were recorded from all study sites. The order Passeriformes was numerically the dominant order represented with highest number of families 15 and 22 species, which accounts 44.9% of the identified species. At family level, family Accipitridae was numerically the dominant family represented with 11 species which accounts 22.45 %, of the identified species. Two families, family Columbidae and Ardeidae were represented by four species each. The remaining 22 families were represented by one to three species. Out of the species recorded in the area *Corvus crassirostris* was endemic bird to Ethiopia. Among 49 bird species recorded, 44 and 47 species were recorded during wet and dry seasons, respectively and 42 species were common to both seasons. But, 2 and 5 species were exclusive to the Dry and wet seasons respectively (Table 1).

Table 1: List of birds recorded from study area

Order	Family	Scientific name	Common name
Accipitriformes	Accipitridae	*Milvus migrans*	Black kite
		Aquila spilogaster	African hawk Eagle
		Necrosyrtes monachus	Hooded Vulture
		Accipiter minullus	Little-sparrow Hawk
		Lophaetus occipitalis	Long-crested Eagle
		Gyps africanus	White Backed Vulture
		Milvus (migrans) aegyptius	Yellow –billed kite
		Circaetus pectoralis	Black –chested snake eagle
		Accipiter badius	Shikra
		Buteo augur	Augur Buzzard
		Aquila rapax	Tawny eagle
Charadriiformes	Charadriidae	*Vanellus senegallus*	African Wattled Lapwing
Columbiformes	Columbidae	*Streptopelia roseogrisea*	African Collared Dove
		Streptopelia lugens	Dusky Turtle Dove
		Streptopelia capicola	Ring-necked Dove
		Columba guinea	Speckled Pigeon
Galliformes	Phasianidae	*Pternistis harwoodi*	Harwood's Francolin
Pelecaniformes	Threskiornithidae	*Bostrychia hagedash*	Hadada Ibis
		Threskiornis aethiopicus	Sacred ibis
	Ardeidae	*Bubulcus ibis*	Cattel egret
		Ardeolar alloides	Squacco horn
		Egretta garzetta	Little egret
		Egrtta intermedia	Yellow –billed egret
Gruiformes	Gruidae	*Balearica pavonina*	Black crowned crane
Apodiformes	Apodidae	*Apus apus*	Common swift
Bucerotiformes	Bucerotidae	*Bycanistes brevis*	Slivery–cheeked hornbill
Piciformes	Indicatoridae	*Indicator indicator*	Greater Honey guide
Passeriformes	Icteridae	*Agelaius phoeniceus*	Red-winged Blackbird
	Muscicapidae	*Melaenornis chocolatinus*	Abyssinian Slaty Flycatcher
		Bradornis microrhynchus	African Grey flycatcher

Table 1: Cont…

Passeriformes	Hirundinidae	*Hirundo aethiopica*	Ethiopian Swallow
	Laniidae	*Lanius collaris*	Common Fiscal
	Malaconotidae	*Laniarius aethiopicus*	Ethiopian Boubou
	Corvidae	*Corvus capensis*	Fan –tailed Raven
		Corvus crassirostris	Thick-billed raven
		Corvus albus	pied crow
	Passeridae	*Passer swainsonii*	Swanson' s Sparrow
	Estrildidae	*Lagonostica senegala*	Red- billed Fire finch
	Viduidae	*Vidua paradisaea*	Eastern paradise Whydah
	Fringillidae	*Crithagra mozambica*	yellow-fronted canary
		Crithagra citrinelloides	African citril
	Platysteiridae	*Batis minor*	Black-headed Batis
		Platysteira cyanea	Brown-throated Wattle Eye
	Pycnonotidae	*Pycnonotus barbatus*	Common Bulbul
	Sturnidae	*Lamprotornis pulcher*	Chestnut-bellied Starling
		Lamprotornis chalybaeus	Greater Blue-eared Starling
		Poeoptera stuhlmanni	Stuhlmann's Starling
	Turdidae	*Turdus abyssinicus*	Mountain Thrush
	Ploceidae	*Ploceus baglafecht*	Baglafecht Weaver

4.2 Distribution of birds

A variation in the number of bird species and relative abundance was observed among the three-study site. From the 49 species of birds identified during the study period, 39, 33 and 14 bird species were recorded from the three study sites (Airport compound, waste dumping site and wetland) during dry season respectively and 42, 36 and 14 during wet season (Table 2). The airport compound harbored highest species richness during both seasons. Among the birds recorded from study sites Fan –tailed Raven, Hadada Ibis, Thick-billed raven, Red- billed Fire finch, Eastern paradise Whydah, yellow-fronted canary and African citril were found in all sites during both seasons (Table 2).

Table 2: Distribution of birds in different study site during wet and dry season

Scientific name	Common name	Airport compound		Waste dumping site		Wetland	
		Dry	Wet	Dry	Wet	Dry	Wet
Milvus migrans	Black kite	+	-	+	_	_	_
Gyps africanus	White Backed Vulture	+	_	+	_	_	_
Aquila spilogaster	African hawk Eagle	+	+	+	+	_	_
Necrosyrtes monachus	Hooded Vulture	+	+	+	+	_	_
Accipiter minullus	Little-sparrow Hawk	+	+	+	+	_	_
Lophaetus occipitalis	Long-crested Eagle	+	+	+	+	_	_
Ploceus baglafecht	Baglafecht Weaver	+	+	+	+	_	_
Milvus (migrans) aegyptius	Yellow –billed kite	+	+	+	+	_	_
Circaetus pectoralis	Black –chested snake eagle	+	+	+	+	_	_
Accipiter badius	Shikra	+	+	+	+	_	_
Buteo augur	Augur Buzzard	+	+	+	+	_	_
Aquila rapax	Tawny eagle	+	+	+	+	_	_
Vanellus senegallus	African Wattled Lapwing	+	+	_	_	_	_
Streptopelia roseogrisea	African Collared Dove	+	+	_	_	_	_
Streptopelia lugens	Dusky Turtle Dove	+	+	_	_	_	_
Streptopelia capicola	Ring-necked Dove	+	+	_	_	_	_
Columba guinea	Speckled Pigeon	+	+	_	_	_	_
Pternistis harwoodi	Harwood's Francolin	_	_	+	+	_	_
Bostrychia hagedash	Hadada Ibis	++	++	++	++	++	++
Threskiornis aethiopicus	Sacred ibis	_	_	_	_	+	+
Bubulcus ibis	Cattel egret	_	_	_	_	+	+
Ardeolar alloides	Squacco horn	+	+	+	+	_	_
Egretta garzetta	Little egret	_	_	_	_	+	+
Egrtta intermedia	Yellow –billed egret	_	_	_	_	+	+
Balearica pavonina	Black crowned crane	+	+	_	_	+	+
Apus apus	Common swift	+	+	+	+	_	_
Bycanistes brevis	Silvery–cheeked hornbill	+	+	+	+	_	_

Table 2: Cont…

Indicator indicator	Greater Honey guide	_	+	_	+	_	_
Agelaius phoeniceus	Red-winged Blackbird	_	+	+	_	_	_
Melaenornis chocolatinus	Abyssinian Slaty Flycatcher	+	+	+	+	_	_
Bradornis microrhynchus	African Grey flycatcher	+	+	+	+	_	_
Hirundo aethiopica	Ethiopian Swallow	+	+	+	+	_	_
Lanius collaris	Common Fiscal	+	+	+	+	_	_
Laniarius aethiopicus	Ethiopian Boubou	+	_	+	+	+	+
Corvus capensis	Fan –tailed Raven	++	++	++	++	++	++
Corvus crassirostris	Thick-billed raven	++	++	++	++	++	++
Corvus albus	pied crow	+	+	_	_	_	_
Passer swainsonii	Swanson' s Sparrow	+	+	+	+	_	_
Lagonostica senegala	Red- billed Fire finch	++	++	++	++	++	++
Vidua paradisaea	Eastern paradise Whydah	++	++	++	++	++	++
Crithagra mozambica	yellow-fronted canary	++	++	++	++	++	++
Crithagra citrinelloides	African citril	++	++	++	++	++	++
Batis minor	Black-headed Batis	+	+	+	+	_	_
Platysteira cyanea	Brown-throated Wattle Eye	+	+	+	+	_	_
Pycnonotus barbatus	Common Bulbul	_	+	_	+	_	_
Lamprotornis pulcher	Chestnut-bellied Starling	+	+	+	+	_	_
Lamprotornis chalybaeus	Greater Blue-eared Starling	+	+	+	+	_	_
Poeoptera stuhlmanni	Stuhlmann's Starling	+	+	+	+	_	_
Turdus abyssinicus	Mountain Thrush	_	+	_	_	+	+

Note: + denote the species present, − denote the species absent, ++ denote the species common to the three sites.

In the present investigation, a total of 4671 individual birds were counted from the three sites during dry season. Out of this, 1887 birds were from airport compound, 1927 and 857 birds were from waste dumping site and wetland respectively. During wet season a total of 5395 birds were counted from the three sites. Out of this 2378, 2148 and 869 were counted from airport compound, waste dumping site and wetland habitat respectively (fig 4). The highest number of birds were recorded from the waste dumping site during dry season (1927) and 2378 from the airport compound during wet season.

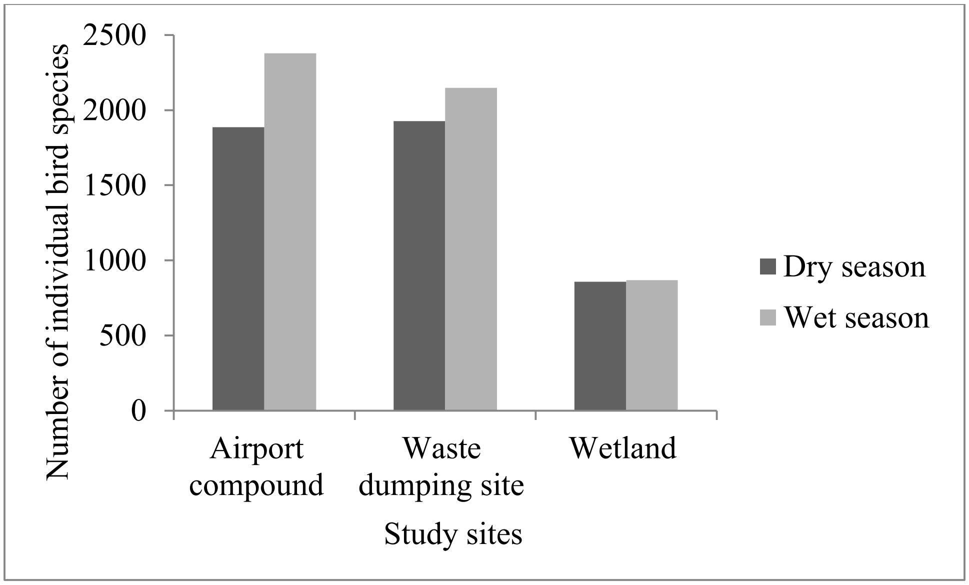

Figure 4: Number of birds counted in and the vicinity of Jimma Aba-Jifar Airport

4.3 Species diversity and Evenness indices

Variations were observed in species diversity of birds among the different habitats during the wet and dry seasons. Bird species diversity was highest in Airport compound (H' = 3.49) and (H' = 3.57) during dry and wet season respectively. In contrast, the lowest species diversity was recorded in the wetland (H’=2.47, H’= 2.58) during dry and wet season respectively. The highest evenness (E=0.96) was recorded in the Waste Dumping Site during the dry season and Wetland (E= 0.98) during the wet season (Table 3).

Table 3: Bird Species diversity (H') and Evenness (E) in three habitat types during the wet and dry seasons in study area

Habitat type	Season	Species richness (R)	Abundance	H'	H'max	E
Airport	Dry	39	1887	3.48	3.66	0.95
compound	Wet	42	2378	3.57	3.74	0.96
Waste	Dry	33	1927	3.36	3.50	0.96
Dumping Site	Wet	36	2148	3.47	3.58	0.97
Wetland	Dry	14	857	2.47	2.64	0.94
	Wet	14	869	2.58	2.64	0.98

Note: H'= Shannon-Weiner diversity index; E= Evenness and R= species richness.

4.4 Relative abundance

The total number of individuals of each bird species reported during the research survey and their relative abundance from the different study sites during the dry season and wet season were as follows in Table 4, 5 and 6.

Table 4 displayed the number of bird species recorded from the airport compound for both seasons. The following species were reported in a decreasing order during the dry season: African citril, yellow-fronted canary, Hooded Vulture and Fan-tailed Raven. Their numbers were the highest: 131, 102, 100 and 90 individuals, respectively. Their relative abundances were 6.9, 5.4, 5.3 and 4.8 respectively. During the dry and wet season, the lowest number of birds was nine and seven individuals with relative abundances of 0.5 and 0.3 for Tawny eagle. The largest number of birds during the wet season was the Red-winged Blackbird followed by African citril, yellow-fronted canary, Thick-billed raven and Speckled Pigeon: 167,111,107,100 and 95 individuals and relative abundance of: 7,4.7,4.5,4.2 and 4, respectively.

Table 4: Relative abundance of bird species in the Airport compound during dry and wet season

Name of species		No of individual count		
Scientific name	Common name	Dry season	Wet season	Both season
Milvus migrans	Black kite	15 (0.8)	-	-
Gyps africanus	White Backed Vulture	31 (1.6)	-	-
Aquila spilogaster	African hawk Eagle	15 (0.8)	15 (0.6)	30 (0.8)
Necrosyrtes monachus	Hooded Vulture	100 (5.3)	94 (4.0)	194 (5.0)
Accipiter minullus	Little-sparrow Hawk	23 (1.2)	50 (2.1)	73 (1.9)
Lophaetus occipitalis	Long-crested Eagle	45 (2.34)	45 (1.9)	90 (2.3)
Ploceus baglafecht	Baglafecht Weaver	50 (2.6)	50 (2.1)	100 (2.6)
Vanellus senegallus	African Watt led Lapwing	30 (1.6)	30 (1.3)	60 (1.5)
Streptopelia roseogrisea	African Collared Dove	67 (3.6)	71 (3.0)	138 (3.5)
Streptopelia lugens	Dusky Turtle Dove	23 (1.2)	31 (1.3)	54 (1.2)
Streptopelia capicola	Ring-necked Dove	64 (3.3)	70 (3.0)	134 (3.4)
Batis minor	Black-headed Baits	15 (0.8)	32 (1.3)	47 (1.2)
Platysteira cyanea	Brown-throated Wattle Eye	34 (1.8)	35 (0.6)	69 (1.8)
Lamprotornis pulcher	Chestnut-bellied Starling	30 (1.59)	43 (1.8)	73 (1.9)
Lamprotornis chalybaeus	Greater Blue-eared Starling	35 (1.85)	47 (2.0)	82 (2.0)
Poeoptera stuhlmanni	Stuhlmann's Starling	29 (1.5)	15 (0.6)	44 (1.1)
Bostrychia hagedash	Hadada Ibis	30 (1.6)	51 (2.1)	81 (2.0)
Ardeola ralloides	Squacco horn	43 (2.3)	25 (0.6)	68 (1.7)
Milvus (migrans) aegyptius	Yellow –billed kite	12 (0.6)	74 (3.1)	86 (2.2)
Circaetus pectoralis	Black –chested snake eagle	17 (0.9)	11 (0.4)	28 (0.7)
Accipiter badius	Shikra	37 (2.0)	43 (1.8)	80 (2.0)
Buteo augur	Augur Buzzard	11 (0.6)	13 (0.5)	24 (0.6)
Aquila rapax	Tawny eagle	9 (0.5)	7 (0.3)	16 (0.4)
Balearica pavonina	Black crowned crane	35 (1.9)	50 (2.1)	85 (2.1)
Columba guinea	Speckled Pigeon	87 (4.6)	95 (4.0)	182 (4.7)
Corvus albus	pied crow	57 (3.0)	75 (3.1)	132 (3.4)

Table 4: Cont…

Apus apus	Common swift	25 (1.3)	34 (1.4)	59 (1.5)
Bycanistes brevis	Slivery–cheeked hornbill	72 (3.8)	79 (3.3)	151 (3.9)
Melaenornis chocolatinus	Abyssinian Slaty Flycatcher	54 (2.9)	76 (3.2)	130 (3.3)
Bradornis microrhynchus	African Grey flycatcher	53 (2.8)	65 (2.7)	118 (3.0)
Lanius collaris	Common Fiscal	65 (3.4)	70 (2.9)	135 (3.5)
Laniarius aethiopicus	Ethiopian Boubou	52 (2.8)	47 (2.0)	99 (2.5)
Corvus capensis	Fan –tailed Raven	90 (4.8)	85 (3.5)	175 (4.5)
Corvus crassirostris	Thick-billed raven	80 (4.2)	100 (4.2)	180 (4.6)
Passer swainsonii	Swanson's Sparrow	62 (3.3)	52 (2.1)	114 (2.9)
Lagonostica senegala	Red- billed Fire finch	81 (4.3)	91(3.8)	172 (4.4)
Crithagra mozambica	yellow-fronted canary	102 (5.4)	107 (4.5)	209 (5.3)
Vidua paradisaea	Eastern paradise Whydah	76 (4.0)	76 (3.2)	152 (3.9)
Crithagra citrinelloides	African citril	131 (6.9)	111 (4.7)	242 (6.2)
Indicator indicator	Greater Honey guide	-	57 (2.4)	-
Agelaius phoeniceus	Red-winged Blackbird	-	167 (7.0)	-
Hirundo aethiopica	Ethiopian Swallow	-	32 (1.3)	-
Pycnonotus barbatus	Common Bulbul	-	25 (1.0)	-
Turdus abyssinicus	Mountain Thrush	-	32 (1.3)	-
	Total=	1887	2378	3906

Note: Relative abundance (RA %) = total number of birds of a particular species/ total number of birds of all species

The numbers and relative abundance of birds at the waste dumping site during the dry and wet season is shown in the data in Table 5.

During dry season Hooded Vulture, Baglafecht Weaver and Hadada Ibis have the highest number of individuals, 150, 150 and 130 respectively. Their relative abundances were 7.8, 7.8 and 6.7 respectively. The lowest number of birds for the Black Kite was nineteen individuals with a relative abundance of 0.1. The largest number of birds during the wet season was the Baglafecht Weaver, followed by Hadada Ibis and yellow-fronted canary as follows: 156, 135 and 112 individuals and relative abundance respectively of 7.3, 6.3 and 5.2. During wet season two species (Black –chested snake eagle and Stuhlmann's Starling) have lowest number of birds with twenty individuals and relative abundance of 0.9 for each species.

Table 5: Relative abundance of bird species in the waste dumping site during dry and wet season

Name of species		No of individual count		
Scientific name	Common name	Dry	Wet	Both
Milvus migrans	Black kite	19 (1.0)	-	-
Gyps africanus	White Backed Vulture	50 (2.6)	-	-
Aquila spilogaster	African hawk Eagle	30 (1.6)	30 (1.4)	60 (1.6)
Ploceus baglafecht	Baglafecht Weaver	150 (7.8)	156 (7.3)	306 (8.2)
Accipiter minullus	Little-sparrow Hawk	45 (2.3)	45 (2.0)	90 (2.4)
Lophaetus occipitalis	Long-crested Eagle	67 (3.5)	52 (2.4)	119 (3.2)
Necrosyrtes monachus	Hooded Vulture	150 (7.8)	81 (3.8)	231 (6.2)
Pternistis harwoodi	Harwood's Francolin	31 (1.6)	34 (1.6)	67 (1.7)
Streptopelia capicola	Ring-necked Dove	53 (2.8)	50 (2.3)	103 (2.8)
Batis minor	Black-headed Baits	46 (2.4)	46 (2.1)	92 (2.6)
Platysteira cyanea	Brown-throated Wattle Eye	28 (1.5)	23 (1.1)	51 (1.4)
Lamprotornis pulcher	Chestnut-bellied Starling	25 (1.3)	43 (2.2)	68 (1.8)
Lamprotornis chalybaeus	Greater Blue-eared Starling	40 (2.1)	41 (1.9)	81 (2.2)
Poeoptera stuhlmanni	Stuhlmann's Starling	21 (1.1)	20 (0.9)	41 (1.1)
Bostrychia hagedash	Hadada Ibis	130 (6.7)	135 (6.3)	265 (7.1)
Ardeola ralloides	Squacco horn	66 (3.4)	61 (2.8)	127 (3.4)
Milvus (migrans) aegyptius	Yellow –billed kite	47 (2.4)	47 (2.1)	94 (2.5)
Circaetus pectoralis	Black –chested snake eagle	30 (1.6)	20 (0.9)	50 (1.3)
Buteo augur	Augur Buzzard	65 (3.3)	45 (2.0)	110 (2.9)
Aquila rapax	Tawny eagle	46 (2.3)	66 (3.1)	112 (3.0)
Apus apus	Common swift	39 (2.0)	27 (1.3)	66 (1.8)
Bycanistes brevis	Slivery–cheeked hornbill	80 (4.2)	83 (3.9)	163 (4.4)
Melaenornis chocolatinus	Abyssinian Slaty Flycatcher	62 (3.2)	76 (3.5)	138 (3.7)

Table 5: cont…

Bradornis microrhynchus	African Grey flycatcher	54 (2.8)	57 (2.7)	111 (2.9)
Lanius collaris	Common Fiscal	34 (1.8)	60 (2.8)	94 (2.5)
Hirundo aethiopica	Ethiopian Swallow	46 (2.4)	36 (1.7)	82 (2.2)
Corvus capensis	Fan –tailed Raven	63 (3.3)	79 (3.7)	141 (3.8)
Corvus crassirostris	Thick-billed raven	55 (2.9)	69 (3.2)	124 (3.3)
Passer swainsonii	Swanson' s Sparrow	31 (3.8)	31 (1.4)	62 (1.7)
Lagonostica senegala	Red- billed Fire finch	73 (3.8)	80 (3.7)	153 (4.1)
Vidua paradisaea	Eastern paradise Whydah	67 (3.5)	71 (3.3)	138 (3.7)
Crithagra mozambica	yellow-fronted canary	97 (5.0)	112 (5.2)	209 (5.6)
Crithagra citrinelloides	African citril	87 (4.5)	91 (1.9)	178 (4.8)
Indicator indicator	Greater Honey guide	-	40 (1.9)	
Agelaius phoeniceus	Red-winged Blackbird	-	90 (4.2)	
Laniarius aethiopicus	Ethiopian Boubou	-	57 (2.7)	
Pycnonotus barbatus	Common Bulbul	-	65 (3.0)	
Turdus abyssinicus	Mountain Thrush	-	29 (1.4)	
	Total=	1927	2148	3725

Note: Relative abundance (RA %) = total number of birds of a particular species/ total number of birds of all species

The data in Table 6 demonstrated the numbers and relative abundance of bird in the wetland site during dry and wet season. During dry season, Sacred ibis, Mountain Thrush and Fan –tailed Raven have highest bird number and relative abundance. Their numbers were the highest as follows: 163,112 and 87individuals. Their relative abundances were 19, 13 and 10 respectively. The lowest number and relative abundance were 12 individuals and 1.4 with Hadada Ibis. During wet season Sacred ibis and Hadada Ibis have highest bird number and relative abundance. Their numbers were the highest as follows: 121and 98 individual respectively. Their relative abundances were 14 and 11.3. The lowest number and relative abundance were 35 individuals and 4 with Ethiopian Boubou.

Table 6: Relative abundance of bird in the wetland habitat during dry and wet season

Name of species		No of individual count		
Scientific name	Common name	Dry season	Wet season	Both season
Bostrychia hagedash	Hadada Ibis	12 (1.4)	98 (11.3)	110 (6.3)
Turdus abyssinicus	Mountain Thrush	112 (13.0)	57 (6.6)	169 (9.8)
Bubulcus ibis	Cattle egret	45 (5.2)	55 (6.3)	100 (5.8)
Egretta garzetta	Little egret	39 (4.5)	65 (7.5)	104 (6.0)
Egrtta intermedia	Yellow –billed egret	55 (6.4)	47 (5.4)	102 (5.9)
Threskiornis aethiopicus	Sacred ibis	163 (19.0)	121 (14.0)	284 (16.0)
Balearica pavonina	Black crowned crane	41 (4.7)	51 (5.9)	92 (5.3)
Laniarius aethiopicus	Ethiopian Boubou	21 (2.4)	35 (4.0)	56 (3.2)
Corvus capensis	Fan –tailed Raven	87 (10.0)	53 (6.1)	140 (8.1)
Corvus crassirostris	Thick-billed raven	32 (3.7)	58 (6.7)	90 (5.2)
Vidua paradisaea	Eastern paradise Whydah	65 (7.5)	72 (8.3)	137 (7.9)
Lagonostica senegala	Red- billed Fire finch	51 (5.9)	40 (4.6)	91 (5.2)
Crithagra mozambica	yellow-fronted canary	75 (8.7)	64 (7.4)	139 (8.0)
Crithagra citrinelloides	African citril	59 (6.8)	53 (6.1)	112 (6.4)
	Total=	857	869	1726

Note: Relative abundance (RA %) = total number of birds of a particular species/ total number of birds of all species

4.5 Bird Attractant features

A number of bird attractant features were observed in and around Jimma Aba-Jifar airport during the study period. These include natural (water body, grassland and wetlands) and human induced attractants, such as: dumping sites, building, light poles, walls, and vegetation. These provide roosting, breeding and feeding sites to different bird species. One of the major attractant features in or around airports was water, used for drinking, bathing, feeding, loafing, roosting and protection for different bird species. The airfield vegetation which incorporated seed-bearing plants also attracts granivorous birds and harbored invertebrates, rodents and snakes. Trees within and around the vicinity of the airport were the natural habitats used for roosting site of different bird species. The presence of wetland around the airport harbors various bird species by providing resource availability such as food and water. The other major attractant feature was waste municipal dumping site around airport. In addition to the presence of Waste dumping site around the airport, improper dumping of food left over from arriving and departing aircraft, residential security policies, cafeterias, and catering services were also the major attractant features by providing feeding habit for different bird species. Many attractants acting in combination were responsible for birds' prevalence in and around Jimma Aba –Jifar airport.

5. Discussion

In the present study, a total of 49 species of bird belonging to 10 orders and 25 families were recorded from all study sites. This result was lower in species richness than the result of Dessalegn (2011) in Addis Ababa bole international airport and Aschalew *et al*. (2017) in Mekelle Alula Aba Nega airport, Ethiopia, they reported 74 and 68 species respectively. This might be due to availability of resource dissimilarities between the study areas. Because availability of resource (food, roosting site and water) was the major factors to determine the number of bird species in given area. But relatively higher than with the result Oduntan *et al*. (2012), 36 bird species were recorded from Murtala Muhammed International Airport, Nigeria. The reason for this could be the survey period conducted only one (wet) season. Avian study covering all seasons was important to get an appropriate data (Dessalegn, 2011). The order Passeriformes was numerically the dominant order represented with highest number of families 14 and 22 species which accounts 44.9 percent of the identified species. This result also in agreement with Dessalegn (2011) and Aschalew *et al*. (2017) in Addis Ababa bole international airport and Mekelle Alula Aba Nega airport, Ethiopia. They reported 52.7 percent and 47.8 percent of the species are belonged to the order Passeriformes. This might be due to its wide range of species and food types (omnivorous, insectivorous, frugivorous and granivorous) (Issa, 2019). Among these, bird recorded from study sites Fan –tailed Raven, Hadada Ibis, Thick-billed raven, Red- billed Fire finch, Eastern paradise Whydah, yellow-fronted canary and African citril were found in all site during both seasons. Species which were found in all study sites during both seasons indicates that necessary requirements like food, water and nesting and breeding sites to these bird species were found in all study sites.

Variation in diversity and number of bird species was observed from different study site. Because of diversity of vegetation within a habitat (Kalkidan and Afework, 2011) and local resource availability, in addition to the size of habitat patches are important factors influencing the distribution of bird species (Dessalegn, 2011). The airport compound harbored highest species richness and diversity than waste dumping site during both seasons. This could be related to the presence of sufficient amount of food and availability of nesting materials owing to water availability in the habitat.

Moreover, the highest species diversity in the airport compound could be due to the diversity of vegetation strata that provides heterogeneous habitat for different avian species. Structurally, complex habitats could harbor more species than sites with simple structure; because there are more niches providing different types of nesting and foraging resources. Similarly, large size of airport compound as compared other study sites might be contributed to highest species richness. In addition to large size of habitat availability various food items also factors to determine the number of bird species in a given area (Aynalem and Bekele 2008; Mengesha and Bekele 2008).

The second site high with bird species richness was in the waste dumping site during both seasons. This might be the presence of resources; especially adequate food supply can increase the abundance of bird species at a given area and due to the adaptability of birds to live in human-modified habitats, where resource is available. The openness of the sites, compared to natural habitats with relatively dense vegetation cover, might have also contributed for easy identification of the species (Kalkidan and Afework, 2011). Sisay (2008) also in his study indicated that, open areas are easily accessible for locating birds.

Season is also a factor to influence the diversity of birds in a given habitat (Kalkidan and Afework, 2011). The decline in the diversity of birds during dry season in a given habitat was due to non-availability of rain, decrease in vegetation productivity, reduction of food availability and sometimes low quality of nesting sites for birds. However, in this study there was no difference in species richness and abundance between seasons in different study sites. This indicates that there is no difference in resource availability (food, water, roosting and breeding site) between seasons in the study area. This maybe because of small and unpredicted rainfall the study area receives in the dry season (Tadesse *et al*., 2012).

The presence of low species richness and abundance in the wetland area might be associated with presence of the similar resource which is selected only by few bird species. In addition, the number of bird species in wetland during the dry and wet season was the same (there were no differences in species richness). This could be related to the availability of moisture and food resources for birds during both seasons.

The relative abundance of African citril, yellow-fronted canary, Hooded Vulture and Fan-tailed Raven was high relative in the airport compound during wet season. During wet season Red-winged Blackbird, African citril, yellow-fronted canary, Thick-billed raven and Speckled Pigeon with high relative abundance. The lowest relative abundance was recorded for tawny eagle during both seasons. In waste dumping site Hooded Vulture and Hadada Ibis were numerically the dominant species and with high relative abundance compared to other bird species during both seasons. The occurrences of high population size of these birds might be associated with resistances towards disturbances and generalist feeding habit of these species as they feed on food scraps and other locally dumped food sources (Melees, *et al*., 2018). In wetland area Sacred ibis, Mountain Thrush and Fan –tailed Raven were with high number of individual and relative abundance during dry season. During wet season Sacred ibis and Hadada Ibis were with high number of individual and relative abundance.

There were different bird attractant features in and around Jimma Aba-Jifar airport, including natural (water body, grassland and wetlands) and human induced attractants, such as, dumping sites, buildings, light poles, walls, and vegetation around the airport. This might be the reason for the presence of different bird species in the study area by providing suitable condition such as feeding, roosting and breeding sites. Dumping sites found near the airport were to be offering abundant feeding resources for many potentially hazardous bird species like kites (*Milvus migrans*) and vulture species. The environment inside the airport favored bird activity. The presence of trees such as Eucalyptus (*Eucalyptus camaldulensis*) and shrubs in and surrounding of the airport served as nesting, roosting and feeding sites of different birds such as vulture, raven and ibis' species. Hangers' light shades, poles, towers inside the airport boundary were also used as nesting and resting sites for pigeon (*Columba livia*). In addition, airports attract doves and pigeons with food sources, water and grit found along roads, taxiways and runways—particularly during rain removal. Earthworms, crickets, frogs which were abundant during wet season were consumed as food sources mainly by the kites (Milvus migrans) and other bird species which are hazard to aviation activities. Small sized birds, which belong to the order Passeriformes, were feeding, resting and roosting on the grasses in the Airport. This could be due to the availability of seed-bearing plants, insect and other invertebrates within the grasslands.

Due to the presence food wastes around apron service areas, cafeterias and waste disposal sites, different bird species including raven and vulture species were observed foraging on food and water resources within and around the airport. Therefore, disposal of garbage by the catering services at the airport should be well managed to discourage scavenging birds from dumps (Dukiya, and Gahlot, 2013).

Generally, Jimma Aba Jifar airport and its surrounding consists of different natural and manmade attractant features to harbor different bird species including hazardous species that poses potential threat to aircraft safety. This result is in agreement with some studies on bird species in and around airport areas (Dessalegn, 2011; Dukiya, and Gahlot, 2013; Lars *et al.,* 2015; Aschalew *et al.*, 2017; Hangeior, 2018); they reported that, airports are often situated close to densely populated areas in which landfills, refuse dumps and waste management sites serve as attractants for many hazardous species. If wetlands are located on or near airport property, be alert to any wildlife use or habitat changes in these areas that could affect safe aircraft operations (Cleary and Dolbeer, 2005).

Bird species were more abundant in the airport compound on and around the runway during morning and late afternoon. This indicates that the presence of these bird species may poses potential threat to aircraft safety, due to this reason which needs attention in order to prevent bird strike problem. For example, different bird species such as kites, eagles, vultures, sturnidae, crows and ravens were commonly observed foraging in waste dumping site and in the airport compound. This indicated that high bird abundances and the location of food wastes and landfills, near airports create a significant bird- strike threat. This is agreed with (Usman, *et al.*, 2012), who reported that high incidence of bird strikes in Nigeria was due to the presence of attractant feature such as thick bushes, waste dumps and farmlands around the airports. According to ranking wild life hazards to aviation; Black kite, Vulture, Pied crow, Cattle egret, Speckled Pigeon, vulture and eagle were the major bird species that poses a potential threat to aircraft safety in the study area (Dolbeer *et al.*, 2000; Hangeior, 2018). In addition to the presence of hazard bird in the study area during the study period some bird species including Ravens, Ibises, egrets and Silvery–cheeked hornbill cross the runway in the mornings from the site where they rest and roost to foraging areas. Those species pose a substantial threat to aircraft safety during departing and landing of the aircraft. This finding was similar with Aschalew *et al* (2017) large body size bird species are the major threat to air craft safety.

Globally; bird strikes have the most common wildlife encounter. The problems have caused damage to aircraft, cost airline industry, and loss of human life. However; there was no confirmed case of bird strike incidence during the study period in the study area. This might be due to applying bird control method by assigning bird chasing personal on the side of the run way in order to control bird strike before landing and takeoff of the aircraft. However, due to the presence hazardous bird species in the study area additional effective bird control measures should be carried out by the airport authorities in order to mitigate bird strike problem.

6. Conclusion and Recommendations

6.1 Conclusion

Due to the presence of natural and human modified attractant feature, significant number of bird species including endemic bird were recorded in and the vicinity Jimma Aba-Jifar Airport during the study period. The highest species richness and diversity of birds was recorded in the airport compound. Because the airport has a number of natural (grassland, water, vegetation and trees) and human induced bird attractant features such as light pole, waste dumping site, building and hanger. The area possesses favorable places for birds to nest, rest, roost and a good access to food as well as water resources. The grassland which is the dominant feature of the area, harbors seed bearing plants, and inhabits rodents, reptiles, insects and other invertebrates. The wetland also found to be attractant as water and food resource. Municipal waste dumping site near the airport plays a great role in attracting different birds' species.

These ecological factors attract large number and various species of birds including hazard birds' species. The presences of these hazardous birds in and around the airport compound pose potential threat to aircraft safety during departing and landing of the aircraft. Therefore, bird control method should apply by the airport authorities to control bird strike problem of Jimma AbaJifar Airport.

6.2 Recommendation

On the basis on the results of the study, the following recommendations are suggested:

- Adequate grassland habitat and other vegetation management should be used to effectively prevent birds from the airport environment .
- It is essential to eliminate seed-bearing and flowering vegetation that attracts birds from the airfield area.
- Garbage disposal by the airport's catering services should be well-managed to keep scavenging birds away from dumps.
- The municipal waste disposal site near the airport should be moved to another location away from the airport.

- It is important to formulate regulations in order to develop and enforce an effective bird management plan in and around the airport.
- Finally, other researchers should conduct further research on the diversity of animals in airport environments and their threat to aviation activities.

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Appendix

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Appendix 1. Transect Count Field Data sheet for bird survey

Habitat: ______________________

Date: ________________________

Transect number _______________

Weather______________________

Starting time: __________________

Finishing time: ________________

No	Time Observed	Common Name	Scientific name	Number of individuals	Activity

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Appendix 2: Point Count Field Data sheet for bird survey

Habitat: ________________________

Date: ___________________________

Station number: ___________________

Weather: _________________________

Starting time: ____________________

Finishing time: ___________________

No	Time Observed	Common Name	Scientific name	Number of individuals	Activity

List of plates

Plate 1: The grassland during the dry season

Plate 2: The grassland during the wet season

Plate 3: Waste Disposal area near the run way

plate 4: Wetland area near the airport

Plate 5: *Columba guinea (*Speckled Pigeon) Plate 6: *Agelaius phoeniceus (*Red-winged blackbird)

Plate 7: *Bubulcus ibis (*Cattel egret) Plate 8: *Balearica pavonina (*Black crowned crane)

 

Plate 9: *Threskiornis aethiopicus (*Sacred ibis) Plate 10: *Corvus crassirostris* (Thick-billed raven)

 

Plate 11: *Bostrychia hagedash* (Hadada Ibis) plate 12: *Milvus migrans (*Black kite)


Plate 13: *Necrosyrtes monachus (*Hooded Vulture) Plate 14: *Corvus albus (*pied crow)


Plate 15: cattle egrets cross airport Compound from feeding site to roosting site.

plate 16: Fan –tailed Raven (*Corvus capensis)*

Note: Source of all pate by Belaynesh Gulal